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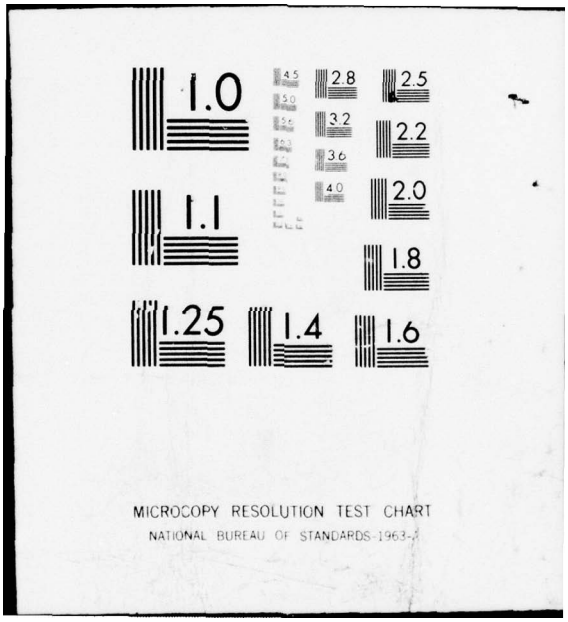
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DEFENSE SYSTEMS MANAGEMENT COLLEGE

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

DEPARTMENT OF DEFENSE DIRECTIVE 5000.29:
INITIAL NAVY IMPLEMENTATION AND CRITIQUE

STUDY PROJECT REPORT

PMC 76-2

JOHN S. CORNETTE

GS-13 DNC

FORT BELVOIR, VIRGINIA 22060

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: Department of Defense Directive 5000.29: Initial Navy Implementation and Critique

STUDY PROJECT GOALS: To research the Directive background and intended application; to define Navy implementation policy; to evaluate and to make recommendations.

STUDY REPORT ABSTRACT: This report summarizes Department of Navy initial implementations of Department of Defense Directive 5000.29 "Management of Computer Resources in Major Defense Systems". Based on interviews and document research, discussion is presented treating philosophies and actions of the Assistant Secretary of the Navy, the Chief of Naval Operations, the Chief of Naval Materials and the Naval Systems Commands. Brief history and overview of the Directive are included; a critique, addressing the Directive generally, rather than from the Navy viewpoint, and general recommendations on the Directive complete the study. No conclusions are drawn due to the formative nature of responses to the recently issued Directive.

KEY WORDS: EMBEDDED COMPUTER SYSTEMS
SOFTWARE ACQUISITION MANAGEMENT

NAME, RANK, SERVICE	CLASS	DATE
John S. Cornette, GS-13, DNC	PMC 76-2	November, 1976

DEPARTMENT OF DEFENSE DIRECTIVE 5000.29: INITIAL NAVY IMPLEMENTATION AND CRITIQUE

Study Project Report

Individual Study Program

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John S. Cornette
GS-13 DNC

November, 1976

Study Project Advisor
LCDR Susan Anderson, USN

This study project report represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinions of the Defense Systems Management College, the Department of the Navy or the Department of Defense.

EXECUTIVE SUMMARY

The purpose of this study is to present the initial Navy implementation of Department of Defense Directive 5000.29, "Management of Computer Resources in Major Defense Systems". A critique of scope, goals and applications plus summary recommendations regarding the Directive completes the study. Coverage of implementation within the Department of the Navy extends to tactical weapons systems acquisition and deployment. A brief historical overview of events leading to Directive issuance is included.

ACKNOWLEDGMENTS

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To my wife for her typing skills and her patience.

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SECTION I

INTRODUCTION

Purpose of the Study Project

The basic objective of this project is to provide insight into the management reaction to and implementation of a Department of Defense (DOD) Directive within the Department of the Navy. The project was undertaken in order to examine the rapidly underfolding changes in overall management approach within DOD and the Navy particularly by a current investigation of the philosophies, problems and systems. The investigation draws heavily on interviews at all levels within the Department of the Navy, supplemented by a survey of available literature.

Scope

This report is limited to Navy acquisition management of software associated with weapon systems. Software associated with weapons systems is deployable and operational; this represents the meaning of Embedded Computer Systems (ECS) within this report. The contents derive largely from interviews within the Assistant Secretary of the Navy (ASN), Chief of Naval Operations (CNO), Chief of Naval Material (CNM) and Naval Systems Commands (SYSCOMs), as current actions are precipitating from these levels.

Considering the formative nature of the topic material, a cut-off date of 15 October 1976 was selected, in order to support report submission requirements; interviewing and literature research were thus restricted. Where possible, trends and plans are noted, with the full understanding that accurate anticipation of future events is impossible.

The original intention was to provide clearly separable statements regarding implementation and critique. However, in the process of real time examination of Directive scope and impact, the formative nature of the implementation approach was clearly predominant, to the extent that implementation and critique were not divorcible. Therefore, the critique is concerned almost exclusively with a DOD perspective, rather than from the Navy viewpoint.

SECTION II

BACKGROUND

A brief summary of those events instrumental to the issuance of DODD 5000.29 is presented here. Only major events, studies or organizations are mentioned; sufficient sources are listed in the bibliography to permit research in greater depth. It is also noted that each source necessarily draws heavily from his own background.

If current real-time tactical weapon systems including software capabilities (taken as synonymous with Embedded Computer Systems (ECS) for purposes of this study), are recognized as having materialized and rapidly evolved within the past decade or so, the generic parent still must be regarded as general purpose automated data processing (ADP). Regarding ADP, general government concerns (for efficient management and use) trace from the mid-1950s. The composite of these concerns were built into the Brooks' Bill;[1] this Bill is the first significant milestone in the path leading to promulgation of DODD 5000.29. Also in 1965, OMB Circular A-71[2] marks the stated origin of Executive Branch interest in effective management of ADP.

Zempolich,[3] in an Industrial College of the Armed Forces (ICAF) study, summarizes DOD developments regarding ECS (also ADP within the government) through the early 1970s. The ECS chronology, predominately Navy, highlights: efforts of the

Naval Command, Control and Communications Automation Preliminary Review Group (C^3APRG); the Reich report and the Navy Laboratory Computing Committee; and the establishment of the Navy Tactical Automated Data Systems Office (TADSO, MAT-09Y). Other ECS related developments within the Navy during the 1960s included establishment of management controls regarding program content. Issuance of WS-8506 "Requirements for Digital Computer Program Documentation"(4) and formulation of Navy shipboard and airborne automated tactical data systems standards (NTDS/ATDS), relative to displays and communication, as in ship-to-ship communication, are examples.

The Pontius study,(5) a Defense Systems Management College Independent Study Project, picks up the chronology essentially at the Completion of a prior reference (3) and delineates events through 1975. An OSD (I&L) staff study ("Tactical Computer Software Acquisition and Maintenance," 1973)(6) and the two-phase study of Management of Weapon System Software, as afforded by the MITRE(7) and John Hopkins University/Applied Physics Laboratory (JHU/APL)(8) area studies are cited. These provide the detailed back-up to the Directive. Additional investigatory efforts leading to DODD 5000.29 include those of the Software Steering Committee, later linked to the Software Reliability Work Group of the Joint Logistics Commanders.

Most recently, the major precursor of DODD 5000.29 has been the Defense Systems Software Management Plan,(9) published

10 March 1976. The Directive, itself, issued 26 April 1976. Subsequent briefings with industry include an AIAA Seminar in June, 1976. Minutes of the Seminar provide a broad perspective of policy guidance, practices, procedures and actions to be taken.(10)

SECTION III

OVERVIEW

DODD 5000.29 is a collection of statements regarding ECS management policy, practices, procedures and techniques. The overall intent is decentralized management within a structured framework of operation, consistent with the requirements for standardization of computer resources.(11) The Directive addresses policy in seven broad management areas: validation and verification; risk analysis; configuration management; life cycle planning; support software deliverables; milestone definition and attainment; and software language standardization and control.

ECS are approached by the Directive through a segmented definition rather than by a single direct definition: embedded being "integral to, from the design, procurement and operations point of view"; and computer systems or resources being "totality of computer equipment, computer program, computer data, associated documentation, personnel and supplies."

Though the Directive is limited to 6 years effectivity, the concept itself seems quite durable; the microprocessor/distributed system of the near future is penultimately ECS, both from an architectural design standpoint and from the ingrained tactical system procurement philosophy.

ECS is distinct from general purpose ADP by almost any comparison or standard, from procurement quantities to

compactness and ruggedness of design, from modularity and flexibility to responsiveness. Consequently, a basic premise of the Directive is that the Comptroller function of ADP procurement is inappropriate to ECS. Though management elements have general addressability in any processing system, their relative criticality and phasing constraints in ECS and ADP are sufficiently variant to justify separate treatment developed in the Directive. Evolution of ECS since the mid-1960s has further defined differences with ADP. Accordingly, exclusions from 5000.29, including: OMB Circular A-71; DODDs 4105.55, 4160.19 and 5100.40 all related to ADP; as well as general purpose, commercially available ADP, are deemed appropriate.

Though Directive scope covers major Defense programs, its principles are appropriate to non-major programs as well. Ultimate integration into the Weapon System Acquisition is provided through absorption into DODDs 5000.1, 5000.2 and 5000.3 prior to Directive expiration; in the interim, biannual reviews will be conducted to address the continuing need for 5000.29 as well as any organizational institutions attached thereto.

Responsibilities are cited, commensurate with the policy and practices, with emphasis on review and update of existing practices, procedures and techniques. Primary focus in this process is the DOD Management Steering Committee for Embedded Computer Resources (MSC-ECR), formerly

the Weapons Systems Software Management Steering Committee. DOD component inputs to the Committee are to include: guidance documents; personnel training and career paths; and R&D programs via Technology Coordinating Papers.

The style of the Directive is similar to that of DODD 5000.1. Both contain a mixture of policy and practices, procedures and techniques. Both are written at a very high level in order to have Tri-Service applicability; this necessitates the compact format--5 and 7 pages respectively. Each represents an assimilation and gleaning of ideas in use, albeit non-uniformly, throughout the Services. The assimilation in each case is intended to provide significant adjustments and consequent improvements to the acquisition process.

The most significant change aspect relates to risk reduction in the total sense. Developmental risks are to be scaled down through concentration on those areas of high risk prior to DSARC II (inception of full scale development). This combines application of techniques previously successful to hardware (front-end loading) with earlier visibility to software to regiment risk reduction. In that same vein, operational requirements are to receive earlier, fuller visibility and scrutiny; the user is to be involved, though not deeply, in the initial design phase, perhaps even co-located with the developer during conceptual and validation phases.(12) Similarly, R&D programs will be examined for overall balance and analyzed in

terms of probability of validating objectives. All these points are aimed at demonstrating risk reduction through the DSARC processes.

Standardization relates to minimization and avoidance of proliferation; a single best characteristic of ECS may not be universally appropriate, however, as exemplified by consideration of support tools. Also in this category, higher order language (HOL) introductory strategy is being approached from a timed commitment viewpoint, based on inventory resources, minimizing overlap and availability.

SECTION IV

INITIAL NAVY IMPLEMENTATION

Interim, 1975

As might be expected, the individual Services were not totally unprepared for the issuance of this Directive. Throughout the Navy, existing policies and practices are in large measure identifiable with the Directive.

In 1975 following the MITRE and JHU studies, NAVMAT issued a CAPSTONE Directive identifying two objectives: sort out basic principles of software management appropriate to the forthcoming DODD; and identify R&D efforts required to support essential elements of DODD. CAPSTONE inputs were then directed upward through OPNAV, CNO, ASN and eventually to DEPSECDEF and the DSARC principals.

Also, in 1975, in the area of configuration management, OPNAVINST 4130.1 (Configuration Management of software in surface ship combat systems; policies concerning)[13] was issued, emphasizing life cycle considerations, interface design specifications and maintenance agencies. Software Configuration Control Boards (CCBs) were mandated, including identification of the roles of (subsystem) Participating Managers (PARMS) and Ship Logistics Managers (SLMs) and mechanics of Board operation and resolution of disagreements. An update of NAVMATINST 4130.2 (Configuration Management of Computer Software Associated with

Tactical Data Systems and other Technical Computer Systems)[14] was drafted for consistency with OPNAVINST 4130.1.

Conversion of non-standard programs to standard systems began receiving an increasing amount of consideration. This consideration involved a cost-effectiveness analysis for deployed systems, as well as a lessons-learned forward projection for new developments in terms of selection of system language.

In terms of management guidance, preparation began in 1975 on MIL-STD-1679 (Tactical Software Development);[15] in depth discussion on this item is presented in a later section.

Validation and verification became an accepted discipline and was applied to the AN/BQQ-5 program among others. Software language and machine standardization and control had largely stabilized within the Navy in the early 1960s with the introduction of CM-2 (Navy standard high level language) and the AN/UYK-7 (Navy shipborne standard computer) so that minimal efforts are viewed as necessary in these areas.

Individual SYSCOMs expended increased attention to prediction and control of software development costs and risk analysis. In particular, a NAVSEA study[16] collected data from several development programs with the objective of correlating mission requirements with program size and development cost. Analysis was extended to functional break-out of the total cost, to operational and support software development differences and to new development compared with update of existing programs.

Data gathering from contractors revealed some insight into the "black art" nature of estimating; new bids derive heavily from past experiences, including cost growth experience (parametric estimation is largely in infancy). The necessity of disciplining computer system development in cost breakout and control of milestones is stressed.

Further discussion of current Navy Implementation is pursued on an organizational basis. Principal on-going actions are outlined by organization in Appendix A.

Assistant Secretary of the Navy (ASN)

At this level, response to the Directive focuses on development of a "family" of products and subsequent enforcement to the basic family. A family may be a Combat System, such as an aircraft carrier command, control and communications (CV/C^3)-- in any event a platform-tie is indicated. The family consists of a standard hardware set, instruction and architect set and a designated support facility; subsequent enhancements are attached to the basic family, with maximum automatic reduction possible and desired. Proper enforcement culminates in full potential for establishing a later second source capability and permits building an experienced personnel base and facility resource. All programs, concepts and designs are thus to be keyed to a requirements and/or platform base.(17) The wisdom of this "keying" is apparent based on recent situations in the All Applications Digital Computer (AADC) and in the Aegis Program.

The R&D strategy is one of moving from 6.2 through 6.4 in an integrated fashion in order to output basics for an improved procurement package. The family concept is laced in 6.3 programs with design-to-price intended for interfacing (different) sensors to the family. A comprehensive R&D Plan is targeted for completion during the second quarter of CY 1977, with initial factoring into the FY 1978 budget.

An additional element of response is the stress to be placed on developmental test sites. This ties in well with

risk reduction measures (early integration efforts leading to earlier problem resolution), while at the same time complementing the establishment of an expertise in personnel base and providing means of strengthening career and training objectives. The next significant planned item in test sites is the establishment of a CV/C^3 test site at NELC, San Diego, presently scheduled for POM-80 execution. This will support aircraft carrier combat suites including Tactical Flag Command Center (TFCC) and National Command Authority (NCA).

Finally, direction from ASN to CNM has gone forward to require creation of a Deputy Chief of Naval Material (DCNM) for ECS and general purpose ADP. This will be further analyzed in the next section.

Chief of Naval Operations (CNO)

Several reorganizations are underway or planned within the Navy both emanating from the Directive and predating it. In June, 1975, to facilitate improved co-ordination and control of ECS, OP-94 (previously Command Support Program) was reorganized with appropriate responsibilities and authorities and renamed Director, Command, Control and Communications Program. Since that time, additional changes have been deemed necessary and restructuring to establish Command, Control and Information Systems Division (OP-942) reporting to OP-94 implemented. This Division will be charged with the execution of many of the functions previously under Combat Direction System Division (OP-034) and Information Systems Division (OP-091). Further, OP-942 will have central responsibility for providing coordination and guidance for both general purpose ADP and ECS computer resources. The reorganization was approved 1 October 1976. In addition certain functions resident in OP-034 were transferred to MAT-09Y; this change has not yet been implemented and further discussion is postponed to the next section.

Personnel within OP-034 and OP-942 have drafted "An Implementation Plan for Computer Resources Management in Tactical Defense System"(18) in response to the Directive at the request of ASN (R&D). On completion and approval in CNO and ASN, the Plan, which will outline the Navy approach, will be forwarded to ASD (I&L).(19) Similar responses are being developed by the

other Services, though it is believed in more detail than the Navy Implementation Plan. An OPNAVINST will be prepared, following Plan approval by ASD, which will further detail and delineate Navy actions; this instruction will likely issue in the first quarter of CY 1977.(20)

The Implementation Plan addresses each of the elements of Section V of the Directive. Its overall intent is stated as

> "to provide more effective performance in areas such as standardization and configuration control of hardware and software, procedures and cost for development and support of software, personnel performance, and the state-of-the-art in computer resource technology."(21)

The approach is thus one of comprehensive guidance, with an aim of flexibility rather than undue or disruptive constraints. The Plan also provides coverage for the Marine Corps. Systems within Navy Acquisition Categories I, II and III are covered within the Plan; general purpose ADP is excluded as in the Directive. New programs are obviously effected, though existing programs may be excluded from compliance in event of significant impact or disruption.

To provide better support to systems intercommunicating through automated digital data links, the Plan notes that establishment of a Naval Tactical Interoperability Support Activity (NTISA) has been proposed. Such an agency would control development, test and maintenance of Navy, joint and international interoperability standards. In the area of support software, the criticality of life cycle support is addressed as well as concerns for the ASPR language of "limited" or "restricted

rights". Unlimited rights are noted as necessary in developments outside Navy standard systems and CMS-2, with contractual coverage to so reflect. The Navy position relative to Higher Order Language (HOL) is observed as historically well based and presently consistent with DOD attitudes. Guidance documents (MIL-STD-1679 and Computer Resources Management Manual) are cited; these will be discussed in the next section. Finally manpower efforts, including training and personnel needs, and R&D efforts are outlined and discussed.

Chief of Naval Material (CNM)

Within the Naval Material Command (NMC), Directive related actions stem principally from the TADSO Office (MAT-09Y) and from the R&D area (MAT-03). As mentioned in the last Section, planning has been initiated effecting TADSO, through transferring in approrpiate functions to establish a more complete sphere of responsibility, consistent with desired control and through corresponding staff increases. Since other factors are involved, such as ASN direction to establish a DCNM for ECS and ADP and repeated unsuccessful planning efforts regarding establishing a Computer Systems Command, planning involving TADSO is still incomplete. As an aside, it is noted that among other Services, the Army has established a Computer Systems Command (CSC) at Ft. Belvoir, Va. However the current major Army Command and Control program, Army Tactical Data Systems (ARTADS), has since been chartered as an independent program with no direct working arrangement with CSC. Thus, apparently establishment of a CSC is not a panacea in terms of universal problem solution.

The TADSO Office is directing the generation of guidance documents, MIL-STD-1679 Tactical Software Development,[22] as mentioned earlier, and a Life Cycle Plan which is based on NAVAIRINST 5230.5.[23] A draft of the MIL-STD was released in June, 1976. The first review cycle has been completed with many comments received (including a change of document number):

a revision is now in process. This document relates to 3 types of tactical software: application; test and maintenance; and support. Logistic support and ADP systems are excluded. The Tactical Data Systems Glossary (March, 1976)[24] is a referenced document, containing definitions of operational and technical terms. The MIL-STD provides guidance through General and Detailed Requirements. General Requirements briefly address design (performance) changes, standardization, test and development visibility. The Detailed Section is rather explicit in terms of program generation, design, standards and conventions, quality assurance, management control, etc. Requirements for Contract Data (most items taken from SECNAVINST 3560.1[25]) and for transition to the software support activity are portions directly attuned to DODD 5000.29.

TADSO is also preparing a Computer Resources Life Cycle Management Manual, starting from a base of the NAVAIR Plan and making appropriate additions and modifications to provide general application within NMC and all SYSCOMs. This document is intended to guide management in procedures, structures and contractual matters, including a general contract data requirements list (CDRL) and statement of work (SOW).[26]

MAT-03, at the direction of ASN (R&D), has generated NAVMAT Notice 5420, "NAVMAT Council for R&D in Computer Sciences."[27] This Notice, to ultimately be superseded by a NAVMATINST, delineates Navy R&D philosophy, approach and strategy. First a top-down validation Plan is to be established, relating

objectives to proposed efforts and proposed efforts to specific, quantified, time-scaled tasks. Priorities for undertaking these tasks are then set, based on relevance, objectives, pay-off, implementability and probability of success. Finally, the specific strategies of acquisition management research are developed.(28) The Council itself establishes at least an appearance of centralized management; its mission is one of creating balance and co-ordination of 6.1-6.4 programs and of eliminating redundancy. The Council consists of five committees with the following functions: setting objectives via the top-down approach; developing mechanisms for determining priorities; microprocessor/micro-computer standardization (for input into SECNAV or NAVMAT implementing instruction); technology transfer (for fleet use); and developing management strategies. An integral Council function is document review to include Navy Decision Coordinating Papers (NDCPs), Operational Requirements (ORs), Development Proposals (DPs) and Advanced System Concepts, again striving for balance, coordination and eliminating redundancy. The Council Charter also calls for Designation of an R&D Program Manager for Computer Sciences.

In addition, MAT-03 has compiled, again at the direction of ASN (R&D), a "Draft Plan for an R&D Program for Computer Resources Management in Navy System".(29) This Plan describes all elements within 6.1-6.4 Programs as well as setting out co-ordinated comprehensive approaches. The Plan is anticipated to complete routing to ASN (R&D) for final approval during the first quarter of CY 1977.

Naval Systems Commands (SYSCOMs)

Naval Air Systems Command (NAVAIRSYSCOM)

As noted in the two previous Sections, NAVAIR has promulgated Responsibility and Requirements for Preparation of Software Life Cycle Management Plans (SLCMP), NAVAIRINST 5230.5. This Instruction provides excellent, comprehensive guidance for establishing structured, controllable programs. Existing programs in NAVAIR are to be reviewed against 5230.5 for consistency and necessary updating, without necessity of gross formatting. The Plan is to be developed prior to the issuance of the Request for Proposal (RFP) for full scale development, with coverage extending to three subsequent phases: development; transition; and software support activity. A Software Change Review Board is called for, with Fleet participation mandatory. The systems engineering process is specified, from configuration items to audits and baselines, from system analysis (Preliminary and Critical Design Reviews) to independent T&E, Validation, Verification and Certification (VV&C), and approval.

In the area of standardization, selection of and initial procurement contract award for the Standard Airborne Computer, AYK-14 were completed in September, 1976.(30) This machine is interface compatible with another Navy standard, the UYK-20 (shipboard minicomputer). These steps have been taken to

solve the proliferation problem. Extant for some years, proliferation can largely be traced to classic design constraints of weight and volume rather than commonality, which now has been accepted as the premier consideration.

Naval Electronics Systems Command (NAVELEX)

All SYSCOMs are supporting the R&D Council and are providing participants to various committees. Perhaps NAVELEX has the heaviest involvement in both Council and Committee; certainly, drafting of the Plan for R&D Program and establishing the Council were efforts involving significant expenditures on the part of ELEX personnel in support of MAT-03.(31)

NAVELEX continues to support CNM in the control and maintenance of the family of standard compilers (CMS-2M, CMS-2Q, CMS-2Y). In the area of language standardization efforts on CHOICE and CS-4 that ELEX had participated in have terminated in favor of DOD-1 under the control of DOD.

This information is believed largely incomplete presumbably due to the state of flux within NAVELEX presently and to the limited number of persons contacted.

Naval Sea Systems Command (NAVSEASYSCOM)

NAVSEA personnel have promulgated several documents keyed to improvement of management control of software development: REEF POINTS (Ship Acquisition), September, 1976;(32) Acquisition Process Instruction;(33) Combat Systems Design Requirements and Operational Design Instruction;(34) and Combat System Computer Program Guidance for Ship Project Directive and Training.(35)

The content of the third document is briefly analyzed here. Combat System Design Requirements (CSDR) and Operational Design (CSOD) are taken as the basis for combat system integration, scheduling and fiscal planning; a premium is accordingly placed on this documentation for the conceptual design phase as well as for subsequent management visibility and tactical use and training.

To better control the significant differences in ship acquisition compared to other Naval Acquisition processes,(36) NAVSEA is pursuing an R&D effort known as PATHWAYS. The major product with development applicability is intended to be an "off the shelf" Software Quality Control Manual, based on polls of lessons learned. Studies thus far conclude that quality assurance of shipboard installed computer programs is characterized by three factors: correctness; ease of modification and transferability.(37) The basic tenor of PATHWAYS is being pursued as an addendum to the Draft Plan for an R&D Program for Computer Resources Management in Navy Systems.

SECTION V

EVALUATION/CRITIQUE

Operations of the MSC/ECR will undoubtedly determine the ultimate effectivity of DODD 5000.29. The Committee is tiered into 2 components in order to insure objectivity and appropriate consideration of alternatives. The existence of this body of a large number of knowledgable people guarantees visibility of and attention to ECS at higher levels of authority; tangible policy and advisory output to DDR&E and DSARC principles are the specified means of communication. Nonetheless, this process can be abused through Committee stagnation, with resulting ineffective decisions and further lagging of overall implementation of effective program management control. Effectiveness of the Committee will therefore depend on its receptivity and selectivity.

The time-limited absorption into DODD 5000.1, 5000.2 and 5000.3 is also of concern. In fact, since the concepts of 5000.29 were not initially directly written into modifications of these three Directives, the status of the concepts is somewhat compromised from inception. If successful hardware development and life cycle practices are directly applicable to software as hypothesized, the intermediate step of 5000.29 could certainly be argued superfluous.

A comparison of the Directive to the two phase study of MITRE and JHU/APL reveals that content is largely common;

however the two-phase study addresses the areas of Program Manager support, software test tools and software work breakdown structure (WBS) without corresponding coverage in the Directive. These later two items are obviously the only concerns for purposes of this study. Mention of software test tools in the Directive is restricted to the deliverable context, without attention to the development function and attendant risk reduction value. WBS presumbably has application at the General Policy level, certainly as a Life Cycle Planning basic consideration.

The basic purposes of separating ADP and ECS are summarized as follows: criticality of performance with corresponding demands for reliability and maintainability; responsiveness to changing operational requirements, demanding change efficiency and supporting detailed documentation; and management of life cycle costs, requiring careful attention to design factors and intersystem standardization restrictions.(38) A significant portion of the Directive rests on the division and maintaining separation of ECS and ADP disciplines; the validity of this thesis has not and perhaps cannot be exhaustively evaluated. Nonetheless, the argument for separation has been accepted by virtue of promulgation of the Directive and the test for its effectiveness, with full visibility and control techniques, set in motion. To gain objective and fair results, the thesis must be tested in the environment of its creation.

Subsequently, based on the test results, present substance must be supplemented and advisory comments further defined. Generally, a two-pronged assault of discipline and understanding must be applied.

The Directive speaks to "correctness of software" and "conformance of . . . resources with stated operational requirements." Though only generally descriptive, these elements relate to lessons learned, thereby emphasizing past mistakes. As a technical area matures, a specific checklist, rehashing problems, can be generated.(39) However, there is no guarantee that these elements or combinations thereof are germane for future developments or efforts. In this sense, the approach is restrictive.

In terms of personnel and training, current problems seem somewhat more complex; ECS demands a dual skill, one not readily available through formal education, but one gained through on-the-job training.(40) Traditionally, these same specialized skills of the software engineer have been met with restricted promotional perspectives; on the other hand, a centralized computer management organization has not been acceptable to the specialist either.(41) These skills are essential to concept formulation, validation and contract definition.

One of several intents of the Directive is to provide front end loading in the interest of subsequent life cycle savings and more effective system capabilities. The process

is one of endoctrination: education of the PM to properly plan, analyze and request the necessary development funds; and to evince a credibility accompanying the capability of proper management to support the appropriation of these funds. A history of incurring design expenses to save life cycle costs must be achieved to support this process. In all likelihood, this process is not only cost-effective, but in light of recent trends in ECS cost history, mandatory.

SECTION VI

RECOMMENDATIONS

Navy implementation is presently directed toward responding to the Directive, toward preparation of a balanced, non-redundunt R&D plan and allocation, and toward identification of responsible organizations, performing under appropriate charters. These approaches are all necessary; the test of their effectivity lies in how well the organizational changes promote better understanding and communication. A particular instance is, those joint programs or programs involving different SYSCOMs which must provide better co-ordination in terms of operator interfaces and life cycle support planning. The Directive does not explicitly treat this area; an early revision is believed useful to indicate relevance.

Successful programs invariably can be traced to effective understanding and consistent discipline.(42) Consequently, perhaps the most important actions the Navy can now take in compliance to the Directive relate to prompt completion and distritution of the guidance documents, a means of maintaining these documents, of insuring that all managers have and continue to have access and finally providing a central point to dispense authoritative supplemental guidance in unique instances as the needs inevitably arise.

Several years ago, the Department of the Navy incurred a substantial expenditure to improve hardware reliability; in

large measure, this effort appears to have been warranted. A key ingredient in this effort was establishment of a high level czar (DCNM for Reliability and Maintainability). If the Navy is seriously concerned about current widespread problems in ECS, creation of another czar, addressing only ECS problems, would seem to be a legitimate starting point.

Current approaches to the personnel problem (training and career paths) have not proved successful; this situation, in fact, has worsened over time. Alternative approaches must be formulated and evaluated. In particular, Defense Systems Management College should take a lead role through curricula changes and through research of alternative approaches.

Finally, R&D efforts should include investigations of top-down constraint approaches to supplement the lessons-learned techniques to counter original problems in future developments.

DODD 5000.29

PRINCIPAL NAVY IMPLEMENTATION ACTIONS

ASSISTANT SECRETARY OF DEFENSE (INSTALLATION AND LOGISTICS)

Directive Promulgation

ASSISTANT SECRETARY OF NAVY

Navy Response to Directive

Strategy Formulation and Co-ordination

CHIEF OF NAVAL OPERATIONS

Implementation Plan

CHIEF OF NAVAL MATERIAL

R&D Plan

Establish R&D Council

Computer Resource Life Cycle Management Manual

MIL-STD-1679

NAVAL SYSTEMS COMMANDS

NAVAIRINST 5230.5 (Life Cycle Plan)

PATHWAYs

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